PATENT APPLICATION BASED ON:

Docket No: 82,831

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TOUCH SCREEN FOR USE WITH AN OLED DISPLAY

Commissioner for Patents
Attn: Box Patent Application
Washington, DC 20231

Express Mail Label No: EL 656965020US
Date: May 24, 2001

TOUCH SCREEN FOR USE WITH AN OLED DISPLAY

FIELD OF THE INVENTION

The present invention relates to touch screens for use with organic light emitting diode displays and, more particularly, to the use of circular polarizing elements to reduce glare and increase the display contrast.

BACKGROUND OF THE INVENTION

Emissive flat-panel display devices are widely used in conjunction with computing devices and in particular with portable devices. These displays are often used in portable devices or in public areas where the use of a keyboard in association with the computer used to drive the display is impractical. In these situations, a touch screen interface to the display is often employed.

A touch screen is a device placed over or above a display which provides a signal when the screen is mechanically touched. There are a variety of detection methods used including capacitive, surface acoustic wave, infrared, and resistive (with either four or five wires). With the exception of the infrared method, each of these methods relies on a hard substrate into or onto which various signals and detecting devices are built.

Fig. 1 shows a prior art touch screen **10**. The touch screen **10** includes a transparent substrate **12**. This substrate **12** is typically rigid, and is usually glass, although sometimes a flexible material, such as plastic, is used. Various additional layers of materials forming touch sensitive elements **14** of the touch screen **10** are formed on top of the substrate **12**. The touch sensitive elements **14** include transducers and circuitry that are necessary to detect a touch by an object, in a manner that can be used to compute the location of such a touch. A cable **16** is attached to the circuitry so that various signals may be brought onto or off of the touch screen **10**. The cable **16** is connected to an external controller **18**. The external controller **18** coordinates the application of various signals to the touch screen **10**, and performs calculations based on responses of the touch sensitive elements to touches, in order to extract the (X, Y) coordinates of the touch.

There are three commonly used touch screen technologies that utilize this basic structure: resistive, capacitive, and surface acoustic wave (SAW). For more information on these technologies, see "Weighing in on touch technology," by Scott Smith, published in Control Solutions Magazine, May 2000.

There are three types of resistive touch screens, 4-wire, 5-wire, and 8-wire. The three types share similar structures. Fig. 2a shows a top view of a resistive touch screen **10**. Fig. 2b shows a side view of the resistive touch screen **10**. The touch sensitive elements **14** of the resistive touch screen **10** includes a lower circuit layer **20**, a flexible spacer layer **22** containing a matrix of spacer dots **24**, a flexible upper circuit layer **26**, and a flexible top protective layer **28**. All of these layers are transparent. The lower circuit layer **20** often comprises conductive materials deposited on the substrate **12**, forming a circuit pattern.

The main difference between 4-wire, 5-wire, and 8-wire touch screens is the circuit pattern in the lower circuit layer **20** and in the upper circuit layer **26**, and the means for making resistance measurements. An external controller **18** is connected to the touch screen circuitry via cable **16**. Conductors in cable **16** are connected to the circuitry within the lower circuit layer **20** and the upper circuit layer **26**. The external controller **18** coordinates the application of voltages to the touch screen circuit elements. When a resistive touch screen is pressed, the pressing object, whether a finger, a stylus, or some other object, deforms the top protective layer **28**, the upper circuit layer **26**, and the spacer layer **22**, forming a conductive path at the point of the touch between the lower circuit layer **20** and the upper circuit layer **26**. A voltage is formed in proportion to the relative resistances in the circuit at the point of touch, and is measured by the external controller **18** connected to the other end of the cable **16**. The controller **18** then computes the (X, Y) coordinates of the point of touch. For more information on the operation of resistive touch screens, see "Touch Screen Controller Tips," Application Bulletin AB-158, Burr-Brown, Inc. (Tucson, Arizona), April 2000, pages 1-9.

Fig. 3a shows a top view of a capacitive sensing touch screen **10**. Fig. 3b shows a side view of the capacitive sensing touch screen **10**. The touch sensitive elements **14** include a transparent metal oxide layer **30** formed on

substrate **12**. Metal contacts **32**, **34**, **36**, and **38** are located on the metal oxide layer **30** at the corners of the touch screen **10**. These metal contacts are connected by circuitry **31** to conductors in cable **16**. An external controller **18** causes voltages to be applied to the metal contacts **32**, **34**, **36**, and **38**, creating a uniform electric field across the surface of the substrate **12**, propagated through the transparent metal oxide layer **30**. When a finger or other conductive object touches the touch screen, it capacitively couples with the screen causing a minute amount of current to flow to the point of contact, where the current flow from each corner contact is proportional to the distance from the corner to the point of contact. The controller **18** measures the current flow proportions and computes the (X, Y) coordinates of the point of touch. US Patent 5,650,597, issued July 22, 1997 to Redmayne describes a variation on capacitive touch screen technology utilizing a technique called differential sensing.

Fig. 4a shows a top view of a surface acoustic wave (SAW) touch screen **10**. Fig. 4b shows a side view of a SAW touch screen **10**. The touch sensitive elements **14** include an arrangement of acoustic transducers **46** and sound wave reflectors **48** formed on the face of substrate **12**. The sound wave reflectors **48** are capable of reflecting high frequency sound waves that are transmitted along the substrate surface, and are placed in patterns conducive to proper wave reflection. Four acoustic transducers **46** are formed on the substrate **12** and are used to launch and sense sound waves on the substrate surface. A cable **16** is bonded to the substrate **12**, and contains conductors that connect the acoustic transducers **46** to an external controller **18**. This external controller **18** applies signals to the acoustic transducers **46**, causing high frequency sound waves to be emitted across the substrate **12**. When an object touches the touch screen, the sound wave field is disturbed. The transducers **46** detect this disturbance, and external controller **18** uses this information to calculate the (X, Y) coordinate of the touch.

Fig. 5 shows a typical prior art organic light emitting diode OLED flat panel display **49** of the type shown in US Patent 5,688,551, issued November 18, 1997 to Littman et al. The OLED display includes substrate **50** that provides a mechanical support for the display device. The substrate **50** is typically glass, but

other materials, such as plastic, may be used. Light-emitting elements **52** include conductors **54**, a hole injection layer **56**, an organic light emitter **58**, an electron transport layer **60**, and a metal cathode layer **62.** When a voltage is applied by a voltage source **64** across the light emitting elements **52** via cable **67**, light **66** is emitted through the substrate **50**, or through a transparent cathode layer **62**.

Conventionally, when a touch screen is used with a flat panel display, the touch screen is simply placed over the flat panel display and the two are held together by a mechanical mounting means such as a frame. Fig. 6 shows such a prior art arrangement with a touch screen mounted on an OLED flat panel display. After the touch screen and the OLED display are assembled, the two substrates **12** and **50** are placed together in a frame **68**. Sometimes, a narrow air gap is added between the substrates **12** and **50** by inserting a spacer **72** to prevent Newton rings.

Flat-panel displays have a problem that is also present when touch screens are used in conjunction with the displays. Ambient light incident on the front surface of either the flat panel or the touch screen is reflected from the front surface to the viewer's eyes, as is illustrated in Fig. 7 (prior art). In Fig. 7 a touch screen with components **12** and **14** are placed above a display with components **50** and **52**. Light **100** is reflected from the surfaces of the components together with emitted light **101**. This reflected light **100**, or glare, reduces the percentage of light from the light-emitting display **101** that reaches the viewer's eyes thereby reducing the perceived brightness and effective contrast of the display. This problem is commonly dealt with by placing a polarizing filter (generally circular) between the viewer and the reflective surface. Fig. 8a illustrates this with a filter **110** placed above the display and Fig. 8b with a filter **110** placed above the touch screen. However, the use of additional filters within a composite flat-panel display with a touch screen creates additional processing steps, requires additional components, and creates additional interlayer reflections which raise costs, reduce reliability, and reduce performance

There is a need therefore for an improved touch screen for use with an OLED flat panel display that reduces reflections and increases contrast of the display, while containing manufacturing costs.

SUMMARY OF THE INVENTION

The need is met according to the present invention by providing a touch screen for use with an organic light emitting diode (OLED) display that includes: a substrate having a top side and a bottom side; a plurality of touch screen elements located on the top side of substrate; and a polarizing element for reducing glare and improving contrast of the OLED display, wherein the polarizing element is an integral part of the touch screen.

ADVANTAGES

The present invention has the advantage that it reduces the costs and improves the reliability and performance of a touch screen that is used with an OLED flat-panel display by eliminating the need for a separate polarizing filter layer.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram showing the basic structure of a prior art touch screen;

Fig. 2a and 2b are schematic diagrams showing the structure of a prior art resistive touch screen;

Fig. 3a and 3b are schematic diagrams showing the structure of a prior art capacitive touch screen;

Fig. 4a and 4b are schematic diagrams showing the structure of a prior art surface acoustic wave touch screen;

Fig. 5 is a schematic diagram showing the structure of a prior art organic light emitting diode (OLED) display;

Fig. 6 is a schematic diagram showing the combination of a touch screen with an OLED display as would be accomplished in the prior art;

Fig. 7 is a diagram illustrating the problem of reflected light from the surface of a display device;

Fig. 8 is a diagram showing the use of polarizing filters to reduce glare as is implemented in the prior art;

Fig. 9 is a diagram showing the use of polarizing filters to reduce glare as is implemented in the prior art;

Fig. 10 is a diagram illustrating the present invention for a touch screen and emissive display;

Fig. 11 is a diagram illustrating the present invention for a touch screen and emissive display wherein the touch screen and emissive display share a common substrate;

Fig. 12 is a diagram illustrating the present invention for a resistive touch screen and emissive display wherein the touch screen and emissive display share a common substrate; and

Fig. 13 is a diagram illustrating the present invention for a touch screen and emissive display wherein the touch screen and emissive display share a common substrate;

DETAILED DESCRIPTION OF THE INVENTION

According to the present invention, OLED display devices overcome the problem of ambient reflections by incorporating polarizing materials into an existing component of a touch screen employed with the OLED display. Polarizing glasses and plastic films are well known in the art and are available in sheet form and with the appropriate mechanical and chemical properties suitable for use within touch-screens and OLED displays.

There are several embodiments in which the present invention can be applied. In the first embodiment, the substrate **12** of the touch-screen itself incorporates the polarizing element. Referring to Fig. 10, a touch-screen **10** includes a polarizing substrate **120** (replacing substrate **12**) and touch screen elements **14**. The touch screen is placed above an OLED display **49** with a substrate **50** and light emitting elements **52**. The polarizing substrate **120** absorbs the ambient light that passes through it while the light emitted from the OLED display **49** is not absorbed. A typical circular polarizer consists of a linear polarizer above a quarter-wave plate. As light passes through the linear polarizer it is polarized linearly. As the light passes through the quarter wave plate this polarization is converted to a rotational polarization. When light is reflected back,

the rotation is reversed. As the reversed, reflected light passes through the quarter wave plate again in the opposite direction, the linear polarization is re-established but, because of the reversal, the polarization is at ninety degrees from the original and the light is absorbed by the linear polarizer. The emitted light passes though the circular polarizer only one time and is not absorbed. Circular polarizers are commercially available from 3M Inc. in both flexible plastic and rigid glass in a variety of configurations.

Referring to Fig. 11, in a second embodiment, a polarizing substrate **122** acts as both a substrate for the touch-screen **10** and a substrate for the OLED display **49**, replacing elements **12** and **50**, and eliminating the need for the spacer **72** in Fig. 6. In either embodiment shown in Figs. 10 and 11, the present invention is applicable to capacitive, surface acoustic wave, or resistive touch screen technologies. These applications will differ only in the mechanical qualities of the substrate. For example, surface acoustic wave substrates are considerably thicker than is necessary for resistive devices.

Referring to Fig. 12, in a third embodiment applicable to resistive touch-screen devices, the substrate does not incorporate polarizing materials. Instead, the flexible polarizing protective layer **124** replaces the flexible protective layer **28** shown in Fig. 2b.

Referring to Fig. 13, in a fourth embodiment a resistive touch-screen **10** shares a common substrate **50** with an OLED display **49**. A polarizing flexible protective layer **124** replaces the flexible protective layer **28** of the touch-screen components **14** in the touch screen **10** shown in Fig. 2b.

In a preferred embodiment, the invention is employed in a device that includes Organic Light Emitting Diodes (OLEDs) which are composed of small molecule polymeric OLEDs as disclosed in but not limited to US Patent 4,769,292, issued September 6, 1988 to Tang et al. and US Patent 5,061,569, issued October 29, 1991 to VanSlyke et al. Many combinations and variations of organic light emitting displays can be used to fabricate such a device.

The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

PARTS LIST

10	touch screen
12	substrate
14	touch sensitive elements
16	cable
18	controller
20	lower circuit layer
22	flexible spacer layer
24	spacer dot
26	flexible upper circuit layer
28	flexible top protective layer
30	metal oxide layer
31	circuitry
32	metal contact
34	metal contact
36	metal contact
38	metal contact
46	acoustic transducer
48	acoustic surface wave reflector
49	OLED flat panel display
50	substrate
52	light emitting elements
54	conductors
56	hole injection layer
58	organic light emitters
60	electron transport layer
62	cathode layer
64	voltage source
66	light
67	cable
68	frame
72	spacer
100	light
101	emitted light
110	filter
120	polarizing substrate
122	polarizing substrate
124	flexible polarizing protective layer